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The policy conflict research of interested parties for the efficient management of research equipment: With focus on the government and the scientist

Donghun Yoon[1*]

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*Corresponding author: Donghun Yoon, Seoul Center, Korea Basic Science Institute, 145 Anam-ro, Seongbuk-gu, Seoul, 02841, South Korea
E-mail: ydh0@kbsi.re.kr

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Additional information is available at the end of the article

Abstract: In this paper, the existing research on the policy conflict with regards to the efficient management of research equipment are presented and discussed for the benefit of the interested parties: the government and scientists. The policy improvement and solution plans are then discussed. In the study, a survey was conducted among 30 scientists (10 university scientists, 10 research institute scientists, and 10 enterprise scientists) on the R&D research equipment policy conflict for the policy conflict research of the aforementioned interested parties in relation to the efficient management of research equipment. Based on the survey results, a conflict resolution policy is proposed for the efficient management of research equipment. The results of this research are expected to help resolve the R&D policy conflict and contribute to the management and operation activation of research equipment. Towards these ends, it is hoped that the results of this

Donghun Yoon

ABOUT THE AUTHOR

Donghun Yoon is currently a Senior Researcher and Team Leader in the Seoul Center, Korea Basic Science Institute. His research areas of interest include management information system, network system, RFID, basic science, research equipment, national large research facilities, science and technology policy, information and communications technologies, R&D strategy, IC-Card and technology diffusion theory. He received his PhD from Graduate School of Media and Governance, Keio University of Japan. He worked for Samsung and the Keio Research Institute at SFC, Keio University of Japan before joining Korea Basic Science Institute. He was awarded 2018 Albert Nelson Marquis Lifetime Achievement Award and was selected 2018 Marquis Who's Who in the World for his contribution to the academic research. He is an Editor-in-chief of International Journal of R&D Innovation Strategy and an International Editorial Review Board of three international academic Journals, International Journal of Operations Research, Information Systems and Innovations in Information Systems for Business Functionality and Operations Management, and International Journal of Asian Business and Information Management.

PUBLIC INTEREST STATEMENT

In this paper, the policy conflict researches of the interested parties for the efficient management of research equipment are presented and discussed. The policy conflict is defined as the conflict of interest between the government and the scientists in the public R&D business and its execution by the central government, local government, public institution, etc. The causes of policy conflicts between the government and scientists were analysed, and an attempt was made to establish an effective policy conflict management method. Based on the survey results, a conflict resolution policy is proposed for the efficient management of research equipment. The results of this research are expected to help resolve the R&D policy conflict and contribute to the management and operation activation of research equipment. Towards these ends, it is hoped that the results of this research will be utilized in laboratories, the basic sciences, and the management and operation activation of research equipment through research result sharing all over the world.

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Subjects: Strategic Management; Management of Technology; Innovation Management

Keywords: policy; conflict; government; scientist; research equipment; R&D; science and technology; management

1. Introduction

The recent years marked the beginning of the fourth industrial revolution based on the global science and technology trend. Since then, productivity has increased rapidly, and the social and economic structures have been reorganized through artificial intelligence (AI), the Internet of Things (IoT), big data, etc. The boundaries between the online and offline computing environments and between virtual reality and science on one hand and the humanities and arts on the other are crumbling. Convergence visualization is under way for services manufacturing and technology industry. In particular, the importance of basic science research for changing the landscape of technology and industry is continuously increasing. In the age of the fourth industrial revolution, the importance of basic science research has increased through the innovation of the market-industry structure. The great leap of AI in recent years has laid the foundation for technological development in basic science research, such as in mathematics, statistics, and computer science research. Major countries such as the United States, Japan, and China are continuing to invest in basic science research. Open innovation is spreading through open R&D diffusion, by increasing the social responsibility of science and technology, and by using ideas and resources to cope with the demand for technology longevity, cycle reduction, R&D convergence, and lower costs. In the past three years (2013–2015), Google invested a total of USD13.3 billion in venture capital.

South Korea is actively preparing for the fourth industrial revolution and has sufficient potential to achieve much in that realm. In terms of potential, the country's world-class information and communications technology (ICT) infrastructure and global manufacturing base can serve as opportunities for it to assume a leading role in the fourth industrial revolution. South Korea's ICT infrastructure took the top place in the ICT Development Index for the second consecutive year (2015–2016) (International Telecommunication Union, ITU). In South Korea, household appliances, automobiles, semiconductors, and displays can be combined with intelligent information technologies like AI and IoT to create new growth opportunities. The country, however, is even further strengthening its future growth engine by expanding the proportion of basic science research in the government R&D programme. The proportion was 40.2% in 2017, but the proportion of basic research investment in the government budget is expanding (2011: USD3.2 billion, 30.7% → 2012: USD3.5 billion, 33.8% → 2013: USD3.8 billion, 34.1% → 2014: USD4.2 billion, 36.3% → 2015: USD4.7 billion, 38.4% → 2016: USD4.7 billion, 38.4% → 2017: USD4.7 billion, 38.4%). This notwithstanding, scientists are constantly raising the need to expand the basic research from the bottom up.

In South Korea, the National Assembly issued a petition (5 October 2016) for the expansion of basic research. Its main contents are as follows. The overall scale of the basic research support project for free public offering should be expanded to the level in the advanced countries, and the scale of the current small-headed free public offering basic research project should be expanded. The government R&D investment base has been maintained, without any change in the short term. In the basic sciences, the availability of research equipment is most important for professors, scientists, researchers, and engineers. Thus, the main task of the Ministry of Science, Technology, and Information (MoST) of South Korea is to improve the efficiency of research equipment management and operation for basic R&D. The mutual utilization of research equipment, the improvement of the utilization rate, and the transfer of idle and underutilized research equipment are being promoted by MoST through the government-led core R&D policy for revitalizing basic

R&D. Scientists are requesting that they be granted autonomy for basic research, and that the government R&D budget be expanded to revitalize basic R&D. Applied research can produce many results in the short term, but because basic research is required in the long run, the sustained time, cost, manpower, and efforts of the scientists lead them to demand that a mid- to long-term government R&D policy for basic research be formulated. In particular, professors, scientists, researchers, and engineers agree with the R&D policy, which aims to improve the efficiency of government research equipment utilization, and insist that the R&D policy must reflect the characteristics of the laboratory, basic research, and research equipment.

In this paper, the existing policy conflict research of the interested parties (i.e., the government and scientists) in relation to the efficient management of research equipment are presented and discussed, then the policy improvement and solution plans are discussed.

2. Policy conflict

The national government, local governments, public institutions, etc. are the parties in policy conflict (Gibler, 2017). This means that policy conflicts unfold in relation to issues related to a large number of interests in the process of establishing and enforcing policies, business plans, laws and regulations, etc. Policy conflicts are difficult to resolve because they involve a large number of interested parties and issues (Lunn, 2016). In particular, they can even escalate due to the large number of interested parties. These conflicts bring about loss of money and time, mutual distrust, and inefficiency on the part of the interested parties (Okech, Pimpleton-Gray, Vannatta, & Champe, 2016). Since recently, the interest in conflict management, which can reduce the negative impact of conflicts and encourage mutual consultation, has been growing (Beyene, 2017). In this study, policy conflict is defined as the conflict of interest between the government (central government, local government, public institution, etc.) and the scientists in the public R&D business and its execution by the central government, local government, public institution, etc. The representative policy conflicts are recognized as involving development activities that destroy the environment in major public works like roads, railways, and dams despite the environmental impact assessment. Conflicts constantly occur in public works. The social overhead capital construction projects, such as the highways and high-speed trains, are frequently drifting or being stopped due to conflicts with the business operators, such as the government (central government, local government, public institution, etc.), residents, and environmental groups. In the past, the government led the way, and the majority of the people passively agreed to it. In recent years, however, various forms of conflict occurred due to the increase in the people's consciousness level, desire to participate in the policymaking process, and heightened interest in the environment.

Conflict management is the process of establishing structures and conditions that will help prevent early conflicts from expanding into dysfunctional and destructive ones, and that will help increase the cases of resolved conflicts (Zimmer, 2017). In conflict management, alternative dispute resolution (ADR) is recognized as a more effective method than conflict resolution through the courts (Hopeck & Harrison, 2017). The United States, Germany, Japan, and other major countries have established laws and systems for conflict management to prevent policy conflicts and to actively respond to the existing ones (Singh, 2017). In particular, the United States utilizes ADR as a way of resolving conflicts in various areas, such as in the courts, governments, public institutions, non-profit organizations, and corporations. Policy conflict resolution can be achieved through mutual consensus among the interested parties, and can be sustained. It also improves the relations among the interested parties. The concept of cooperative governance is shown in Figure 1.

3. Policy conflict types

Policy conflict progresses through the processes of creation, development, growth, and extinction. In the process of conflict creation and extinction, cause–relation interaction occurs. Therefore, the conflicts are few, with the same situation and cycle, and conflicts appear in various forms (Golpayegani, Dusparic, Taylor, & Clarke, 2016). Conflicts are difficult to effectively

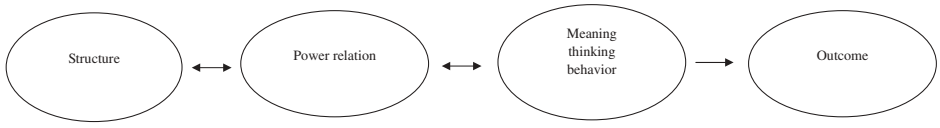

Figure 1. Cooperative governance.

resolve as their causes vary. Identifying a conflict based on its characteristics according to type is useful for achieving conflict resolution (Bassols, 2016). This research considered the classification of conflicts according to the characteristics of public works, the classification according to the conflict personality, and the classification according to the subject of the conflict. The classification according to the cause of the policy conflict is presented in Table 71. A policy conflict can be classified as a profit conflict or an authority conflict according to its characteristics. The profit conflict arises from the interested parties' conflicting socioeconomic interests (e.g., land use, facility location, facility management) (Muboko, 2017). Under it are the interest conflict, attraction conflict, damage conflict, pursuit-of-public-interest conflict, and compensation conflict. The authority conflict, on the other hand, arises predominantly from among the different types of government, such as the right or appropriateness conflict among the interested parties (Quebec & Bloom, 2017). Conflicts or disputes arise between the central and local governments in the areas of licensing and property management, disposal, and use. In terms of the subjects of conflicts, conflicts can be divided into those between government organizations and those between the government and the residents.

4. Policy conflict management factors

4.1. Conflict management factors

The factors affecting public conflict resolution are the government conflict management factors. These can be categorized into the traditional and alternative approaches. The traditional conflict management approach is often perceived as the judicial solution and includes self-management strategies (Freking, 2016; Gregersen, 2017). The alternative conflict management method, on the other hand, was initially proposed as a substitute for judicial litigation, but it has various ideological values, such as win-win results, with the stakeholders resolving their disputes on their own, ensuring that everyone wins. The interested parties naturally prefer obtaining win-win results in resolving their conflict, where all of them win. This entails negotiations, mediation, arbitration, etc.

Another approach to public conflict resolution is the economic approach, based on the market economy principle (Hass, 2017). It can be seen as an effective approach to resolving conflicts that arise in relation to interests. A democratic way of resolving conflicts is by utilizing the public participation system, a very important tool in public conflict resolution. It is very important to establish a system of citizen participation. In the formation of public policy, the citizen participation system is classified into non-participation, degree of tokenism, and degree of citizen power.

Table 1. Classification according to the cause of the policy conflict

Classification	Definition
Factual conflict	A conflict that arises from differences in the interpretation of facts, data, and conversations
Interest conflict	A conflict that arises in the process of distributing limited resources, etc.
Structural conflict	A conflict that arises from the social, political, or economic structures or from distorted institutions and customs
Relationship conflict	A conflict that arises from relationship problems such as mistrust, misunderstanding, and prejudice
Value conflict	A conflict that arises from value, belief, generational, political, religious, or cultural differences
Identity conflict	A conflict that arises from the act of impairing an individual or group's identity or of compelling an individual or group to embrace a certain identity

4.2. Conflict characteristics factors

The conflict characteristics factors are intrinsic conflict factors involving issues (Kaposi, 2017). They include the policy conflict characteristics. First, a conflict occurs among the concerned parties (individuals, groups, organizations, or governments), who are capable of making decisions in relation to the said conflict and have an interest in the conflict outcomes. Second, issues are a major conflict source among the parties involved. The conflicts based on issues include the understanding, value, relational, data, and structural conflicts. Third, policy characteristics are subject to public conflict, which can also impact conflict resolution. The policy background and characteristics influence the development process of a policy conflict. The extent of the conflict can affect the conflict's outcome depending on the scope of the policy participants, the relationships among the participants, the degree of conflict, and the level of conflict (Vater, 2017; Waxman, 2017).

4.3. Conflict environment factors

Conflicts are affected by the environment, and conflict resolution is influenced by the various institutional frameworks in each society (Leon-Perez, Notelaers, & Leon-Rubio, 2016). The environmental factors of conflict consist of social, economic, and political factors. The political factors include political institutions, political elections, the politicians' interests, and the leadership. The economic factors include economic situations and events. That is, a country's poor economic situation may lead the government to decide to prioritize economic revitalization as a policy, which may bring about conflicts. The social factors are influenced by civic groups and mass media. The growth of and intervention by NGOs or civic groups may play an important role as an environmental factor of conflict (Philpot, Hipel, & Johnson, 2016).

5. Research equipment policy conflict among the interested parties

5.1. Interested party: government

South Korea's MoST is promoting the government R&D policy as a government-led initiative to strengthen the basic research on government R&D and to improve the efficiency of the national R&D investment through the mutual utilization of research equipment, research equipment utilization rate improvement, and the transfer of idle and underutilized research equipment. MoST is managing all the research equipment introduced through the government R&D budget from all the universities, research institutes, public institutions, companies, etc. as the National Science & Technology Information Service (NTIS) management stage of introduction-utilization-operation-disposal. As all the research equipment introduced from the R&D budget are purchased with the government R&D budget coming from the taxes paid by the people, it is but right that all scientists freely utilize them jointly rather than being regarded as the assets of individual scientists or research institutes. The low research equipment utilization rate means that the research equipment is not needed or is not being used for research purposes. Therefore, the research equipment with low utilization rates should be transferred to the scientists who need them or opened for mutual utilization by scientists and research institutes. The mutual utilization is measured by MoST through the mutual utilization rate and the mutual utilization allowable rate. The mutual utilization rate is determined from the internal rule on and guideline for mutual utilization, which charges a user fee for the analysis support service. The mutual utilization allowable rate is not defined by the internal rule or guideline and opens the utilization of research equipment to external scientists who need them, according to the conditions of the scientist who is managing the research equipment. MoST encourages the transfer of idle and underutilized research equipment to the scientists or research institutes who need them. It prevents irrelevant or duplicate research equipment purchase using the government R&D budget through the Research Equipment Purchase Council. MoST supports the purchase of research equipment at an affordable price as well as the purchase of research equipment with a high utilization rate, for mutual utilization. It has established the National Research Facility and Equipment Expansion and Operation Management Advancement Plan (2009) and National Research Facility and Equipment Standard Guideline (2016). Through these, the central government, local governments, public agencies, public

corporations, research institutes, and companies have been managing and operating research equipment. The Board of Audit and Inspection (BAI) of South Korea also inspects the management and operation of research equipment in accordance with the National Research Facility and Equipment Standard Guideline.

5.2. Interested parties: scientists

In this study, "scientists" are defined as all professors, scientists, researchers, and engineers who have a need for research equipment. Scientists utilize research equipment to conduct basic science R&D, and research equipment is an indispensable element in the conduct of their research. High-performance research equipment is useful for scientists to obtain outstanding research results. With high-performance research equipment, scientists can form research groups, conduct research as groups, collaborate with scientists from around the world, produce excellent research results, and build a network of international collaborators.

Scientists regard autonomy in research as very important. They are constantly proposing that the central government and the National Assembly fully support the creation of a government R&D budget for carrying out research, alleviate the burden of excessive research administration, and improve the research management regulation to facilitate research. Scientists want to help strengthen the country's future growth engines through the expansion of the proportion of the government R&D budget allotted for basic science research. As the Nobel Prize is often awarded to scientists who have made a significant contribution to basic research, scientists are motivated to pursue outstanding research achievements. For the operation and management of research equipment, scientists faithfully jot down research notes, make entries in logbooks, manage the research equipment utilization rate, ensure the mutual utilization of research equipment, and input research equipment information in NTIS. Scientists also utilize research equipment to teach new researchers and students how to use such equipment, and to help them utilize these well. They also endeavour to improve the performance of the existing research equipment to facilitate research, or to upgrade or develop new research equipment or propose new related ideas. Since recently, scientists have engaged in the development of new research equipment for the establishment of a new research area, and are exerting continuous efforts to find new related principles. Scientists are eager to explore new areas of research through adventurous and challenging research, and they want to continue their research with a network of scientists around the world. They are purchasing research equipment by availing of a grant from the government R&D budget through the Research Equipment Purchase Council. First, scientists prepare a research proposal and submit it to the central government through the National Research Foundation of Korea, and then to research institutes, to secure a grant from the government R&D budget. Then they prepare a plan report and a use plan for the grant from the government R&D budget, where they indicate their planned purchase of research equipment. The purchase cost of the research equipment is included in the research proposal to be submitted to the Research Equipment Purchase Council, and the application is approved or rejected based on the proposed purchase target and the appropriateness of its cost. The current process of purchasing research equipment with a grant from the government R&D budget is very long and difficult, and the scientists expend much time and effort in acquiring research equipment for their research.

5.3. Policy conflict cause

In South Korea, the representative policy conflict concerns the project base system (PBS) for the government and scientists. PBS was introduced in 1996. In such system, the labour and research costs are not fully covered by a government grant as only a minimal government grant is provided. The remaining costs are covered by the external project. Although PBS seemed to be efficient at first, it has been strongly pointed out that it is the biggest obstacle to creating a stable and future-oriented research atmosphere that is the core of the national R&D. In recent years, MoST also recognized the importance of PBS and has since been trying to modify it. In this paper, the policy conflict researches of the interested parties for the efficient management of research equipment are presented and discussed. The first cause of the policy conflict has to do with the mutual

utilization of research equipment. The relevant government policy states that the research equipment purchased through the government R&D budget should be opened for use to all researchers who need such research equipment, besides research equipment management institutions. Scientists, in principle, agree with and accept the mutual utilization policy, but when the research equipment is opened to all outside researchers, the scientists' research activities are constrained as they have difficulty using the research equipment according to the research schedule. It is difficult to charge external researchers maintenance fees if breakdowns occur in the research equipment they are using or if consumable parts need to be replaced. Also, the samples or materials used with the research equipment may be contaminated by the external researchers using the same equipment. A problem with regard to the security of the research information obtained from the research equipment may also arise, and the leakage of research information to a scientist's research competitors can have very serious consequences. Scientists welcome the mutual utilization of research equipment as it enables collaborative research, but they think that mutual utilization is difficult in cases where the research equipment can only be utilized alone or has high utilization. Moreover, the mutual utilization of research equipment requires scientists to make reservations in advance, which they find very troublesome, and requires the preparation of regulations regarding the opening of the use of research equipment to external researchers.

The second cause of the policy conflict in the aforementioned area is the improvement of the research equipment utilization rate. From the perspective of the government, the utilization rate of research equipment purchased with the government R&D budget and the efficiency of such research equipment's operation and management should be maximized. The aim is to have zero idle and underutilized research equipment throughout the year and to keep all the existing research equipment in continuous operation. MoST determines the average research equipment utilization rate and establishes the general guidelines to improve the scientists' research equipment utilization rate. Below is the detailed formula for the research equipment utilization rate.

$$\textit{Research equipment utilization rate} = \frac{\textit{Research equipment utilization time}}{\textit{Research equipment available time}} \times 100$$

The research equipment utilization time is the sum of the actual and secondary operating times for the research equipment utilization. The actual operating time is the actual time during which the research equipment is being operated for testing, analysis, measurement, training, production, etc. The secondary operating time, on the other hand, is the time during which the research equipment is run incidentally for research equipment pre-heating or pre-use, maintenance, or device cleaning/cleaning post-use. When the research equipment is turned on for no special reason, such is not included in the research equipment utilization time. Below is the detailed formula for the research equipment available time.

$$\textit{Research equipment available time} = \textit{Working day} \times 8\ \textit{Hour}$$

$$\textit{Working day}\,(\textit{Year}) = 5\,\textit{Day}\,(\textit{Week}) \times 50\,\textit{Week} = 250\,\textit{Day}$$

Scientists in principle agree with and accept policies that aim to improve the utilization rate of research equipment, but there are many types of research equipment, and the utilization rate of the same research equipment can vary greatly depending on the research task, characteristic, and group. For example, Korea Polar Research Institute (KOPRI) of South Korea utilizes exploration research equipment only 1–2 months during the year, for exploring Antarctica. How can this be said to be a low rate of research equipment utilization? Scientists think it is better to set the utilization rate of research equipment considering the research tasks, characteristics, and groups. Scientists prefer to set the general guidelines for research equipment utilization by setting the average research equipment utilization rate, but they think that the recommendation should only be preferable and not mandatory. Scientists insist that the maintenance, repair, and training times should be excluded from the research equipment available time when calculating the utilization rate of research equipment. Scientists believe that it is desirable to set the guidelines by setting different research equipment utilization rates depending on the research equipment type.

The third cause of the policy conflict with regard to research equipment utilization is the transfer of idle and underutilized research equipment. The government policy is to transfer idle research equipment that have not been running for more than 6 months, or low-utilization research equipment (i.e., those with an annual utilization rate of less than 10%). The average life span of the government assets of South Korea's Public Procurement Service (PPS) is 5 years, and the same is true for the research equipment, but the government has set up a system that allows the relocation of idle and underutilized equipment without any liability on the part of the concerned research institutions or scientists even if the research equipment is less than 5 years old. The government allows the relocation of idle and underutilized research equipment to research institutes or scientists even before these are needed. In addition, the government shoulders the transfer and repair costs for research equipment. The government believes that the transfer of idle and underutilized equipment can make a significant contribution to the mutual utilization of research equipment and to the improvement of their utilization rate.

Scientists in principle agree with and accept the policy of transferring idle and underutilized equipment, but they insist that many of the idle and underutilized equipment transferred to institutions or scientists are useless, very old, or fit for disposal, and are the non-preferred and unpopular research equipment. They also insist that even with regard to useful and favourable idle and underutilized research equipment, there are cases when the competition among the related institutions or scientists for acquiring these is very intense. Moreover, the administrative procedure for transferring idle and underutilized research equipment is tricky, and oftentimes, no benefit can be derived from the transfer and such transfer is just additional work. Scientists think, however, that they need to change their overall related perceptions, and that research equipment are not their private properties. They also insist that there is an urgent need for the government to establish a viable system for the transfer of idle and underutilized research equipment, and that active publicity for such be undertaken and the best related practices be introduced.

5.4. Policy conflict development process

This section discusses and presents the evolution of policy conflicts, describing how policy conflicts develop between the government and the scientists based on data from MoST. In 2013, MoST carried out the R&D research equipment relocation project for the mutual utilization of research equipment, the improvement of the research equipment utilization rate, and the transfer of idle and underutilized research equipment. To boost the success of the said project, MoST conducted various promotion activities, including the provision of research equipment purchase and R&D cost support to universities, research institutes, companies, and scientists. In the early stages, however, the results of the project were not very good because universities, research institutes, companies, and scientists were not interested in the project and were uncooperative. Thus, the R&D research equipment relocation project came to be in a crisis state. MoST must succeed in the said project, however, because it is key to revitalizing the R&D basic research and is a very important science-&-technology-related policy. In addition, MoST had previously considered the probability that universities, research institutes, companies, and scientists would not be interested or would be uncooperative in the early stages of the implementation of the R&D project, but the R&D research equipment relocation project persisted in performing poorly, endangering the project's continuation. As such, MoST pursued an aggressive policy.

MoST sent 12,287 NTIS users and 1,103 Zone for Equipment Utilization Service (ZEUS) members a promotional e-mail about R&D projects (1 July 2013). In addition, the newspaper Digital Times, an electronic newspaper, posted a recruitment announcement (19 July 2013) on the R&D research equipment relocation project. The R&D project recruitment announcement and the successful R&D research equipment relocation project book were sent to 648 non-profit organizations, 1,617 for-profit institutions, 5,000 university professors, and 140 ZEUS member institutions (19 November 2013). MoST posted advertisements in the August, October, and December issues of the Science and Technology magazine of South Korea in 2013 and tried to promote the project on the Internet through a banner advertisement (26 November 2013). MoST has exerted much effort to boost the

success of the R&D research equipment relocation project, but only the research equipment of 13 institutions (10 December 2013) managed to be relocated. Universities, research institutes, companies, and scientists were not interested and were uncooperative as they thought that the said project was not effective and was not just a recommendation but a push. As a result, policy conflicts began to arise between the government and scientists.

Korea Environmental Industry and Technology Institute (KEITI) and Korean Agency for Technology and Standards (KATS) requested for support from MoST for relocating some of their research equipment. KEITI said that 30 of its research equipment could be relocated, but most of them were industrial equipment or could not be used for basic or applied research. Also, KEITI could not allow these to be relocated due to its internal regulations. As for KATS, it initially said that 70 of its research equipment could be relocated, but as per the recommendation of its research equipment expert, only six research equipment were eventually made available. Further, KATS could also not allow the said research equipment to be relocated due to its internal regulations. National NanoFab Center initially said that six of its research equipment could be relocated, but due to its internal regulations, the possibility of relocating these was eventually negated, which caused confusion. Overall, there were few research instruments that could actually be relocated, and there were many research equipment that had to be disposed of in the long term. This has given rise to a policy conflict between the government and scientists due to the problems involved in relocating research equipment.

In 2007, Hwasun County Office of Jeollanam-do, South Korea signed a memorandum of understanding (MOU) with Fraunhofer Institute of Germany regarding the establishment of Fraunhofer Institute for Molecular Biology. The institute was established in 2011. Jeonnam Provincial Government, Hwasun County Office, and Fraunhofer Institute of Germany closed the institute in 2013, however, due to operational and management conflicts. Thereafter, Jeonnam Provincial Government and Hwasun County Office requested MoST to facilitate the relocation of the institute's 153 research equipment. MoST attempted to relocate the research equipment to the research institutes and scientists nationwide who needed them, but Jeonnam Provincial Government, Hwasun County Office, and the scientists of Fraunhofer Molecular Biology Institute strongly resisted such efforts for the reason that the MOU was signed with Fraunhofer Institute of Germany and the local government invested in the institute's establishment. Therefore, Jeonnam Provincial Government and Hwasun County Office insisted that the institute's research equipment be relocated to the research institutes and scientists in Jeollanam-do and Hwasun-gun. MoST insisted, however, that the central government invested in the purchase of the institute's 153 research equipment, and as such, the said equipment should be relocated based on the National Research Facility and Equipment Standard Guideline and the National Property Act. This matter led to a major policy conflict between the central government and the local governments and scientists.

MoST conducted a field survey on national research facilities and equipment. As a result of the said survey and based on the NTIS information, 2,469 idle and underutilized research equipment were found in 311 institutions (universities, research institutes, companies, etc.). MoST sent a first official letter to the said 311 institutions regarding the Research Equipment Council opening and the transfer of such institutions' idle and underutilized research equipment (31 December 2013), indicating that the transfer result of the said institutions' idle and underutilized research equipment (31 December 2013) should be submitted to MoST not later than 15 January 2014. MoST then sent a second official letter to the 311 institutions for the Research Equipment Council opening and the transfer result of idle and underutilized research equipment based on the National Research Facility and Equipment Standard Guideline and the institutional regulation (10 January 2014), but the overall response rate was only 42.4% (3 February 2014) and the research institutes and scientists were relatively uncooperative.

MoST received the Research Equipment Council result for only 1,344 idle and underutilized research equipment of 132 institutions among the 2,469 idle and underutilized research equipment of the aforementioned 311 institutions. It encouraged the Research Equipment Council opening and the transfer of idle and underutilized research equipment by calling directly for the 1,125 idle and underutilized research equipment of the 179 institutions that did not comply. A total of 67 research equipment were transferred among the 1,344 idle and underutilized research equipment of the aforementioned 132 institutions. MoST sent an e-mail to 13,391 scientists (professors, researchers, etc.) regarding the transfer of the said 67 research equipment. Universities, research institutes, companies, and scientists initially started to show interest in the matter but were uncooperative. Scientists began to insist that the central government had no knowledge of the research field and had made the study environment more difficult by promoting such administrative policy. Universities, research institutes, companies, and scientists in principle agree with the research equipment relocation policy of MoST, but the scientists insisted that the research equipment relocation policy did not consider the situation of the research field and mandated a compulsory act. This led to a major policy conflict between the central government and scientists.

6. Theoretical framework design

In this study, 30 scientists (10 university scientists, 10 research institute scientists, and 10 enterprise scientists) who were involved in the conflict regarding the relocation of idle and underutilized research equipment were surveyed for the policy conflict research of the interested parties for the efficient management of research equipment. The internal consistency reliability was used to ensure the reliability of the survey data. The internal consistency reliability is a parameter of reliability that is used when multiple items are employed to measure the same concept. It identifies the degree of reliability by treating measurement tools or items individually. In particular, it identifies the items that interfere with the reliability among the measurement items. It is used to identify the items that impair the reliability, and to increase the reliability of the measurement tools. In general, it uses Cronbach's alpha. In this study, the Cronbach's alpha value was generally from 0.6 to 0.7 for all the items, and the reliability of the items was high. The reliability of the measurement tool can be maintained and adjusted by selectively using items with a consistently high alpha coefficient for Cronbach's alpha value calculation. The internal consistency reliability is widely used for reliability analysis through Cronbach's alpha. Below is the detailed formula.

$$cronbach's\ alpha(\alpha) = \frac{n}{n-1}\left(1 - \frac{\sum {\sigma^2}_i}{{\sigma^2}_t}\right)$$

n: Number of item

σ_i^2: *Variance of each item*

$\sum \sigma_i^2$: *Variance of total item score*

7. Analysis results

The analysis results for the policy conflict cause cognition are presented in Table 2. The survey results for the cognition of policy conflicts were as follows: 40.0% strongly agreed that the participation of the interested parties was insufficient, 33.3% strongly agreed that there is an absence of consensus culture formation, 46.7% strongly agreed that there is a lack of consensus formation, 33.3% strongly agreed that there is a lack of transparency, and 46.7% strongly agreed that there is an absence of support and cooperation for the resolution of the interested parties' conflict regarding the efficient management of research equipment. Most of the respondent scientists agreed that these factors served as the causes of the conflict. The mean score for absence of support and cooperation was 4.167. It was thus recognized as the biggest cause of the conflict, followed by the lack of consensus formation, the absence of consensus culture

Table 2. Analysis results for policy conflict cause cognition

Conflict cause	Item						Mean	Standard deviation	Cronbach's alpha
	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Total			
Insufficiency of the interested parties' participation	3 (10.0)	3 (10.0)	5 (16.7)	7 (23.3)	12 (40.0)	30 (100.0)	3.733	3.742	0.767
Absence of consensus culture formation	1 (3.3)	3 (10.0)	7 (23.3)	9 (30.0)	10 (33.3)	30 (100.0)	3.800	3.783	0.901
Lack of consensus formation	1 (3.3)	4 (13.3)	6 (20.0)	5 (16.7)	14 (46.7)	30 (100.0)	3.900	4.848	0.845
Lack of transparency	3 (10.0)	2 (6.7)	8 (26.7)	7 (23.3)	10 (33.3)	30 (100.0)	3.633	3.391	0.817
Absence of support and cooperation	1 (3.3)	1 (3.3)	4 (13.3)	10 (33.3)	14 (46.7)	30 (100.0)	4.167	5.788	0.978

formation, the insufficient participation of the interested parties, and the lack of transparency. The standard deviation showed an unstable level, and the cause of the conflict was very influential and the degree of conflict was serious. The Cronbach's alpha value was from 0.6 to 0.7 for all the items, and the reliability of the items was high.

In this paper, the coordination mechanism, participation revitalization, compromise settlement, settlement mediation, legal and institutional management plan, construction of a cooperation support system, and improvement of and training on the conflict management system were surveyed for policy conflict management. Survey questionnaires were formulated and distributed to the respondents. The analysis results for the cognition of policy conflict management are presented in Table 3. For most of the items, the number of respondents who indicated that they preferred policy conflict management was higher than average, and the improvement of and training on the conflict management system showed the highest preference, with a mean score of 4.233. The standard deviation showed the most unstable distribution for compromise settlement, and an unstable distribution in all the items. The Cronbach's alpha value was from 0.6 to 0.7 for all the items, and the reliability of the items was high. These results show that the respondents are in dire need of policy conflict management, and that policy conflict management has not been properly executed.

In this paper, the increase of the scientists and research institutions' profit, the increase of the scientists and research institutions' burden, the conflict resolution possibility, the current conflict resolution level, the feasibility of policy promotion, the reflection of the scientists' opinions, and the contribution to the government's science and technology development efforts were surveyed for individual-recognition analysis for policy conflict situations. The analysis result for individual recognition for policy conflict situation is presented in Table 4. The highest mean score (3.833) was obtained by the increase of the scientists and research institutions' burden, followed by the increase of the scientists and research institutions' profit, the conflict resolution possibility, the feasibility of policy promotion, the current conflict resolution level, the reflection of the scientists' opinions, and the contribution to the government's science and technology development efforts. The most-frequently-asked-about item was the conflict resolution possibility (36.7%). The standard deviation was most stable for the reflection of the scientists' opinions, and the other items were unstable. The Cronbach's alpha value was from 0.6 to 0.7 for all the items, and the reliability of the items was high. These survey results indicate that the conflict is very serious, and as such, it is necessary to promptly establish and promote aggressive policy conflict management.

8. Proposed policy for the efficient management of research equipment

Recently, the society has been experiencing a variety of conflicts that are difficult to resolve. As a result, the society has become fragmented—with the members and the various coexisting cultural communities competing with one another—and has become saturated with the values that figure in the conflict. Societal change involving the formation of diverse cultural communities inevitably leads to conflicts, especially conflicts with regard to the values related to planning and public policy. Therefore, there is an urgent need to develop and research on ways of resolving public policy conflicts related to various government R&D projects. In South Korea, conflict management in government R&D projects and public policy is systematically or realistically government-led, and its role is also beyond the scope of professional advice. In this paper, a policy for the efficient management of research equipment is proposed as a win-win R&D strategy for the government and scientists to resolve their conflicts and to cooperate with each other. A plan for managing conflicts in both directions is likewise proposed.

The first strategy is the mutual cooperation of the government and scientists. It focuses on understanding the true needs of each conflict group and finding solutions to these that can be mutually satisfactory, beyond the boundaries of the other party in the conflict. For the mutual cooperation of the government and scientists, it is desirable for both of them to formulate policies for the relocation of research equipment through the holding of various public hearings, meetings, conversations, and conferences. In addition, the opinions of the scientists in universities, research

Table 3. Analysis results for policy conflict management cognition

Conflict cause	Item						Mean	Standard deviation	Cronbach's alpha
	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Total			
Coordination mechanism	1 (3.3)	6 (20.0)	5 (16.7)	8 (26.7)	10 (33.3)	30 (100.0)	3.667	3.391	0.701
Participation revitalization	3 (10.0)	3 (10.0)	7 (23.3)	6 (20.0)	11 (36.7)	30 (100.0)	3.633	3.317	0.719
Compromise settlement	1 (3.3)	2 (6.7)	6 (20.0)	6 (20.0)	15 (50.0)	30 (100.0)	4.067	5.523	0.858
Mediation in settlement	1 (3.3)	3 (10.0)	4 (13.3)	9 (30.0)	13 (40.0)	30 (100.0)	4.000	4.899	0.916
Legal and institutional management plan	1 (3.3)	3 (10.0)	9 (30.0)	6 (20.0)	11 (36.7)	30 (100.0)	3.767	4.123	0.707
Construction of cooperation support system	1 (3.3)	2 (6.7)	3 (10.0)	10 (33.3)	14 (46.7)	30 (100.0)	4.133	5.701	0.917
Improvement of and training on the conflict management system	1 (3.3)	1 (3.3)	3 (10.0)	10 (33.3)	15 (50.0)	30 (100.0)	4.233	6.245	0.871

Table 4. Analysis results for individual recognition of a policy conflict situation

Individual recognition	Item						Mean	Standard deviation	Cronbach's alpha
	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Total			
Increase of the scientists and research institutions' profit	3 (10.0)	2 (6.7)	5 (16.7)	10 (33.3)	10 (33.3)	30 (100.0)	3.733	3.808	0.814
Increase of the scientists and research institutions' burden	1 (3.3)	2 (6.7)	8 (26.7)	9 (30.0)	10 (33.3)	30 (100.0)	3.833	4.183	0.748
Conflict resolution possibility	3 (10.0)	3 (10.0)	5 (16.7)	8 (26.7)	11 (36.7)	30 (100.0)	3.700	3.464	0.701
Current conflict resolution level	3 (10.0)	4 (13.3)	6 (20.0)	9 (30.0)	8 (26.7)	30 (100.0)	3.500	2.550	0.812
Feasibility of policy promotion	2 (3.3)	3 (10.0)	7 (23.3)	9 (30.0)	9 (30.0)	30 (100.0)	3.667	3.317	0.769
Reflection of the scientists' opinions	4 (13.3)	5 (16.7)	6 (20.0)	8 (26.7)	7 (23.3)	30 (100.0)	3.300	1.581	0.717
Contribution to the government's science & technology development efforts	4 (13.3)	3 (10.0)	5 (16.7)	8 (26.7)	10 (33.3)	30 (100.0)	3.233	2.302	0.850

institutes, and companies can be most efficiently gathered through surveys, and it is best for the government to actively cooperate with the policymakers in reflecting the opinions of the scientists.

The second strategy is to hold negotiations between the government and scientists. Negotiations basically pave the way for each negotiating party's partial concession to the other through dialogue and give-and-take, and for reaching a consensus. Basically, the aim of the research equipment relocation policy is to improve and enhance the government R&D. As the relocation of research equipment will target new scientists or scientists who have difficulty purchasing research equipment, it can be beneficial and can create a win-win situation for the government and scientists. Unilaterally promoting R&D policies for the relocation of research equipment without a precise explanation of such policies, advance notice, and a grace period, however, can aggravate the conflict between the government and scientists.

The third strategy is confrontation, one of the most reasonable conflict management strategies. It involves analysing the issues that are causing conflicts through a dialogue between the government and scientists, where they can clarify their respective positions and which can facilitate their reconciliation by reducing their misunderstandings. The face-to-face method allows the causes of the conflict to be identified and emphasizes mutual trust among the parties in the conflict and encourages them to cooperate with each other even as they pursue their respective interests. This method is an effective way of resolving misunderstandings between the parties involved. In addition, it is important for the government R&D policymakers to examine the research environment and listen to the explanations by visiting as many places as possible in the research field, meeting face-to-face with scientists, and holding extensive dialogues with them. There is an urgent need to establish an R&D policy that faithfully reflects the current situation of the research environment rather than establishing an administrative R&D policy.

The fourth strategy is mitigation, which is a way of reducing the differences between the parties in the conflict (the government and scientists) by emphasizing their similarities and common interests. When the similarities and common interests of conflicting governments and scientists are found and emphasized, the two parties realize that they are not separate entities. This is effective when making reasonable suggestions based on information. Both the governments and scientists in principle believe that the research equipment relocation policy is essential. In view of this common interest, in recognizing that both their starting points and goals for promoting the research equipment relocation policy are the same, it is urgent and necessary for them to agree on the R&D policy process and to promote it positively.

The fifth strategy involves rewards and mutual benefits. As the response strategy to policy conflicts, reward means promising or giving away various values (goods, services, economic substance, status, etc.) that the other party considers important. It means the exchange of mutual benefits. Although the government shoulders only the transfer and repair costs based on the research equipment relocation policy, it is fundamentally beneficial to the scientists and research institutions receiving the research equipment. In the research equipment relocation policy, it is also necessary to expand the government's support system for scientists and research institutes with regard to the introduction of research equipment by shouldering their R&D cost.

9. Conclusions and future research

In this paper, the policy conflict researches of the interested parties for the efficient management of research equipment are presented and discussed. The causes of policy conflicts between the government and scientists were analysed, and an attempt was made to establish an effective policy conflict management method. Applied research can produce many results in the short term, but because basic research requires a long time, the sustained time, cost, manpower, and efforts have moved the scientists to demand a mid- to long-term government R&D policy for basic research. In particular, professors, scientists, researchers, and engineers agree with the R&D policy to improve the efficiency of the government's research equipment. Research equipment is the most critical and essential element in basic research as far as professors, scientists, researchers, and engineers are concerned. In the analysis results for the policy conflict cause cognition, most scientists responded

that they strongly agree that the insufficiency of the interested parties' participation is the primary cause, followed by the absence of consensus culture formation, the lack of consensus formation, the lack of transparency, and the absence of support and cooperation. Scientists are very urgently prodded to establish conflict resolution methods and to apply these quickly. Serious problems arising from improperly done conflict management have occurred. The coordination mechanism, participation revitalization, compromise settlement, settlement mediation, legal and institutional management plan, construction of a cooperation support system, and improvement of and training on the conflict management system were surveyed for policy conflict management. Most of the respondents answered positively and indicated that they wanted to resolve the existing policy conflicts. The government and scientists were designated as the interested parties for the policy conflict research. The results of the policy conflict research are presented for the efficient management of research equipment, then the policy improvement and solution plan are discussed. This research is expected to help resolve the existing R&D policy conflict and to contribute to the management and operation activation of research equipment. Towards these ends, it is hoped that the results of this study will be utilized in laboratories, basic science research, and the management and operation activation of research equipment through research result sharing all over the world.

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Author details
Donghun Yoon[1]
E-mail: ydh0@kbsi.re.kr
ORCID ID: http://orcid.org/0000-0002-8014-4527
[1] Seoul Center, Korea Basic Science Institute, Seoul, South Korea.

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